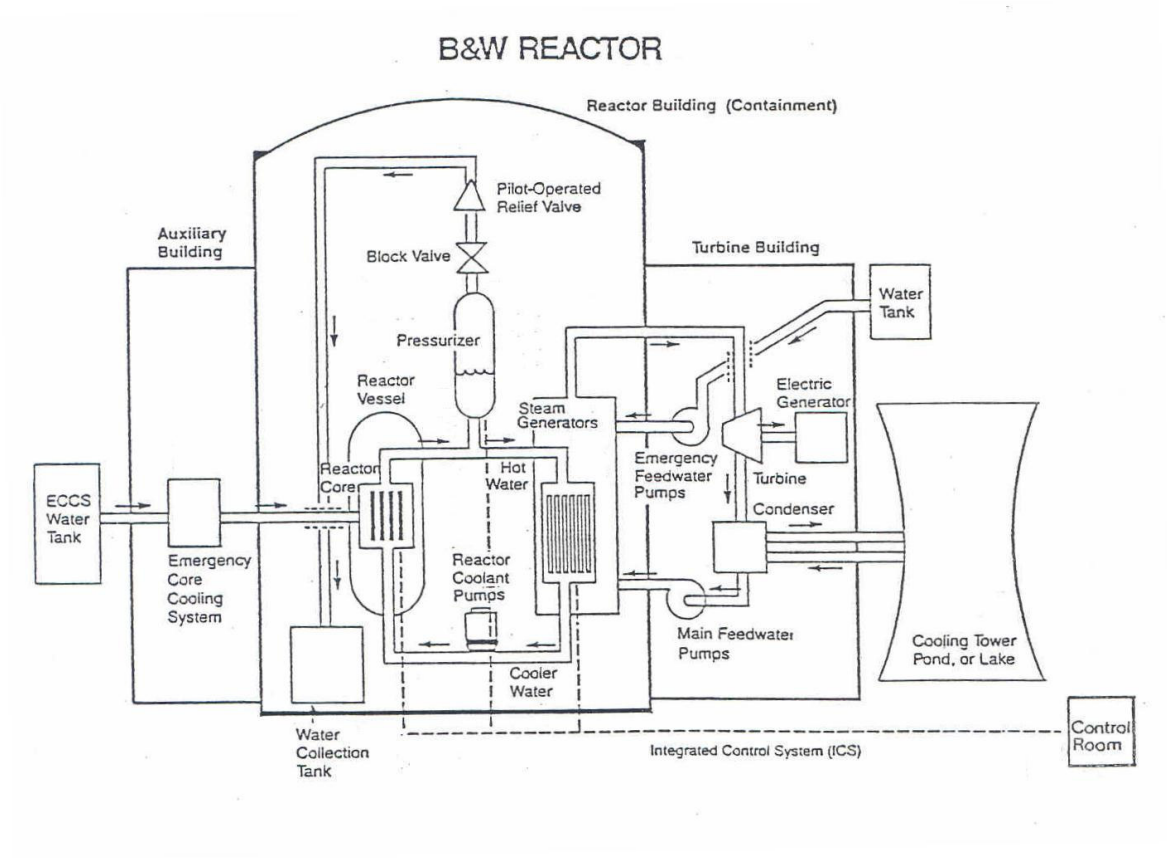
Union of Concerned Scientists
Citizens and Scientists for Environmental Solutions
issue brief

DAVIS-BESSE: BACK TO THE FUTURE

EVENT SUMMARY

Davis-Besse began June 9, 1985, at 90 percent power. There was harmony and balance – the energy produced by the nuclear fuel in the reactor core matched the energy removed through the steam generators. The delicacy of that balance was demonstrated at 1:35am when one of the two main feedwater pumps automatically tripped. The reduced flow of water to the steam generator from the surviving main feedwater pump was not enough to remove all of the energy flowing into the steam generator from the reactor vessel. This energy imbalance caused the pressure of the water circulating through the reactor vessel to rise rapidly. About 30 seconds after the main feedwater pump tripped, the reactor automatically tripped due to the high pressure. Shortly thereafter, the main steam isolation valves (not shown in the diagram, but located on the piping between the steam generator and the turbine) spuriously closed. Their closure terminated the flow of steam to the surviving steam-driven main feedwater pump, so it too stopped providing water to the steam generators. The reactor core, although shut down, still continued to produce a large amount of energy. Water circulating through the reactor vessel heated up as it received energy from the reactor core but could not discharge it via the steam generators. An operator error and equipment failures disabled both of the auxiliary feedwater pumps (labeled emergency feedwater pumps in the diagram). Both of the steam generators boiled dry in about 15 minutes, leaving the reactor core without cooling. As pressure rose in the water circulating through the reactor vessel, the pilot-operated relief valve (PORV) opened to protect the piping from bursting. As happened during the Three Mile Island accident in 1979, the reactor core's cooling water was escaping through the PORV.



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EVENT POTENTIAL

Had the operators not successfully intervened to correct the initial error and fix several equipment malfunctions, the NRC estimated that the reactor core could have been uncovered in 37 minutes and fully uncovered in 41 minutes. The reactor core at Three Mile Island was never fully uncovered, but it was sufficiently uncovered to destroy it. But operators overcame their initial miscue and complicating equipment failures to restore feedwater flow to the steam generators and reinstate cooling of the reactor core. Several steps had been taken along the pathway to meltdown, but fortunately that journey was halted in time.

EVENT CAUSE (TOLERATING THE UNTOLERABLE)

As with the majority of big events, this one at Davis-Besse would not have occurred had at least one aspect been different. The main feedwater pumps showed signs of trouble for several weeks before the event occurred, but those problems were not corrected. In fact, both of the main feedwater pumps malfunctioned one week earlier. Rather than delay restart of the plant so the problems could be fixed, management opted to merely install instruments so the problems could be "monitored" some more. Had the main feedwater pump problems been corrected instead of tolerated, the event would not have happened.

When the first main feedwater pump tipped on June 9th, the remaining main feedwater pump would have been able to increase its output so as to provide the operators with more time to respond. But it had been placed in manual instead of automatic control per management directive following the problem the prior week. Rather than fix the problem, management elected to restart Davis-Besse and operate the two main feedwater pumps in two different control schemes hoping the problem would not disable both pumps.

In any case, the operators lost the remaining main feedwater pump when the main steam isolation valves closed, preventing the supply of steam to this steam-driven pump. The main steam isolation valves closed due to a false signal generated by a pressure instrument installed at Davis-Besse during its refueling outage in 1984. This pressure instrument replaced one that had been used since Davis-Besse started up in 1977. With the new pressure instrument, Davis-Besse experienced two spurious actuations like the one that closed the main steam isolation valves in this event. The old pressure instrument had never caused such an actuation. Had the spurious actuations caused by the new pressure instrument been corrected instead of tolerated, the event would not have happened.

The loss of both main feedwater pumps resulted in the steam generators boiling dry. Dried-out steam generators are unable to remove any of the heat being produced by the reactor core. Operators saw this occurring and acted to prevent it. Unfortunately, they took the wrong step. Intending to manually start the auxiliary feedwater pumps in response to low water level in the steam generators, the operator accidentally hit the button for low pressure in the steam generators. This inadvertent action closed the valves in the piping from the auxiliary feedwater pumps to the steam generators. The auxiliary feedwater pumps started, but valves closed by the operator's errant action blocked the pathway for their water to reach the steam generators. Two separate attempts to re-open the valves from a control room panel and then from a backup panel failed to do so. An operator scurried out into the plant to manually open the valves. Management at Davis-Besse had informed the NRC six months prior to this event that the control system for manual actuation of the auxiliary feedwater system was deficient and could lead to inadvertent isolation of the system – forecasting exactly what happened in this event. While points are awarded for recognizing potential problems, those points must be surrendered when the identified solutions are not implemented before the problem is exploited.

The closed valves were not the only problem plaguing the auxiliary feedwater pumps. Both of the pumps started when requested, but both automatically tripped when their steam-driven turbines oversped. The reasons for these failures has not been determined. The list of possible reasons exceeded a dozen candidates, calling into serious question the efficacy of surveillance testing routinely conducted to "demonstrate" the operability of the auxiliary feedwater pumps.

There was a motor-driven startup feedwater pump at Davis-Besse. But management told the NRC in October 1984 that this pump posed a threat to one of the auxiliary feedwater pumps located in the same room. The startup feedwater pump was not designed to high quality standards and a rupture of its piping could disable that adjacent auxiliary feedwater pump. So the NRC allowed management at Davis-Besse to pull the fuses for the motor-driven startup feedwater pump so it could not be used and therefore could not threaten the auxiliary feedwater pump. Had the troubled pump been fixed rather than intentionally disabled, this event would not have happened.

Now that the main feedwater pumps and the backup auxiliary feedwater pumps had all crapped out, workers turned to the intentionally disabled motor-driven startup feedwater pump. An operator raced through the plant taking five manual actions in four different locations (including re-installing the fuses). The startup feedwater pump began supplying water to the dried-out steam generators about six minutes later.

A few minutes later, other operators were able to remedy the problems plaguing the auxiliary feedwater pumps and were able to belatedly get water to the steam generators using these pumps, too.

The operators' ability to maintain cognizance of plant conditions during the event was hindered by the unavailability of the Safety Parameter Display System (SPDS). The SPDS featured TV-screens that displayed key plant parameters in a user-friendly format. The SPDS had not been original equipment at Davis-Besse – it had been added as a lesson learned from the Three Mile Island accident. But the SPDS had been broken at Davis-Besse before this event and it remained broken throughout this event.

DECADES OR DECADENCE?

This June 9, 1985, event was caused by management tolerating known problems but not fixing them and by the Nuclear Regulatory Commission knowing about the problems but accepting promises rather than performance.

Little has changed in the ensuing two decades. Davis-Besse itself came even closer to meltdown in 2002 than it did that day twenty years ago. Again, both management and NRC knew about plenty of the warning signs but did nothing – unless ignoring counts – about them. Today, the Hope Creek nuclear plant in New Jersey is shut down following its third significant leak in less than nine months. Management is applying and NRC is approving nuclear band-aids to an extremely long list of known problems at Hope Creek rather than fixing them.

Nuclear power plants are designed such that it takes a lot of things to go wrong before a disaster happens. But disaster looms closer and closer when nuclear power plants are allowed to operate with more and more things already wrong such that the list of remaining things needed to go wrong gets shorter and shorter. The NRC should not allow nuclear plants to operate with so many known problems, but it does.

It's not "Decades or Decadence." It's "Decades of Decadence." The Nuclear Regulatory Commission is simply not the nuclear cop on the beat protecting the public from bad management that allows safety levels to drop below an acceptable point.

Prepared by: David Lochbaum

Primary Source: Nuclear Regulatory Commission, NUREG-1154, "Loss of Main and Auxiliary Feedwater Event at the Davis-Besse Plant on June 9, 1985."